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SALMON RUNS - UPPER COLUMBIA RIVER, 1956-57

SPECIAL SCIENTIFIC REPORT–FISHERIES No. 364

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

United States Department of the Interior, Fred A. Seaton, Secretary
Fish and Wildlife Service, Arnie J. Suomela, Commissioner
Bureau of Commercial Fisheries, Donald L. McKernan, Director

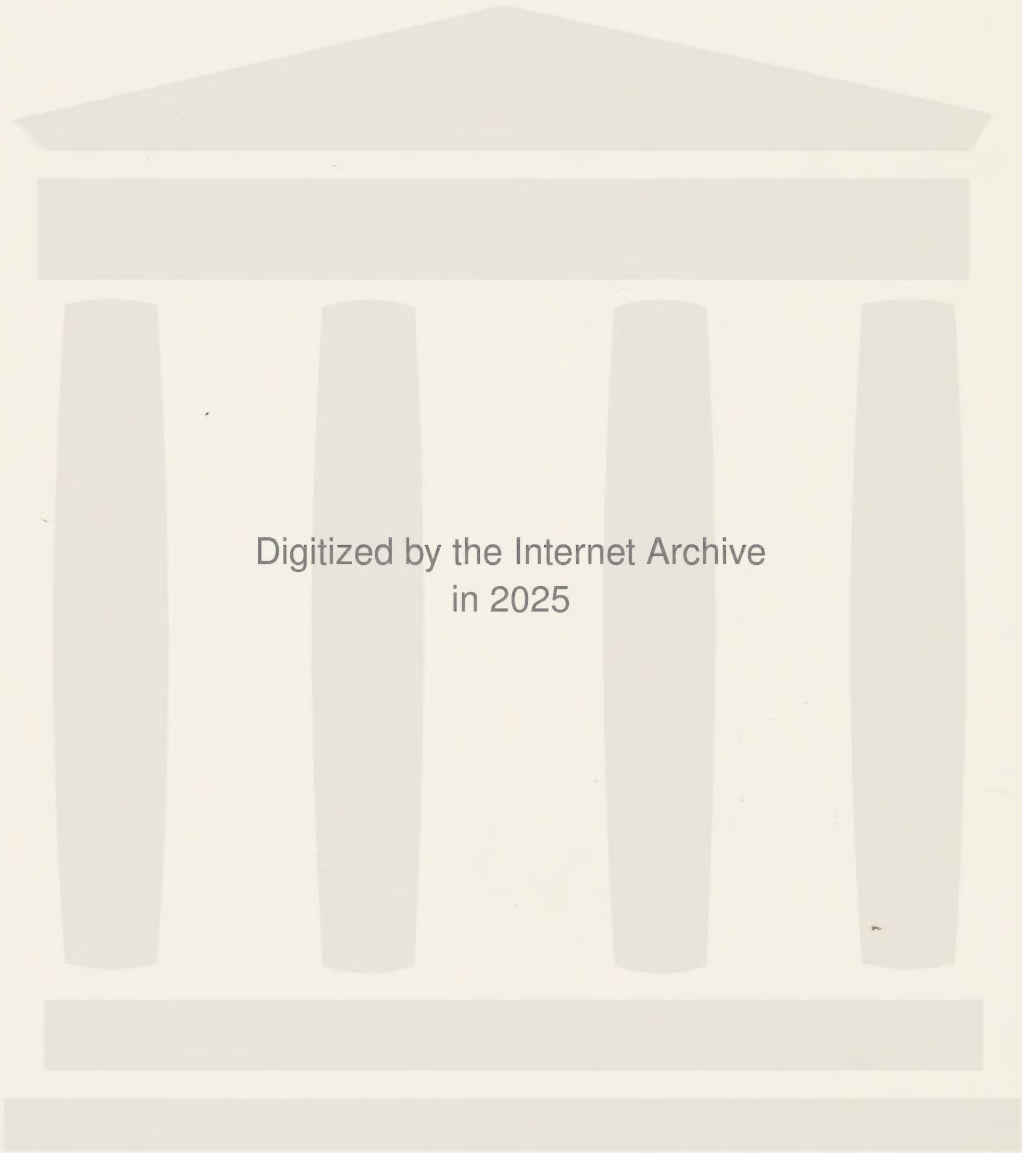
SALMON RUNS - UPPER COLUMBIA RIVER, 1956-57

by

R. R. French and R. J. Wahle

United States Fish and Wildlife Service
Special Scientific Report--Fisheries No. 364

Washington, D. C.
October 1960



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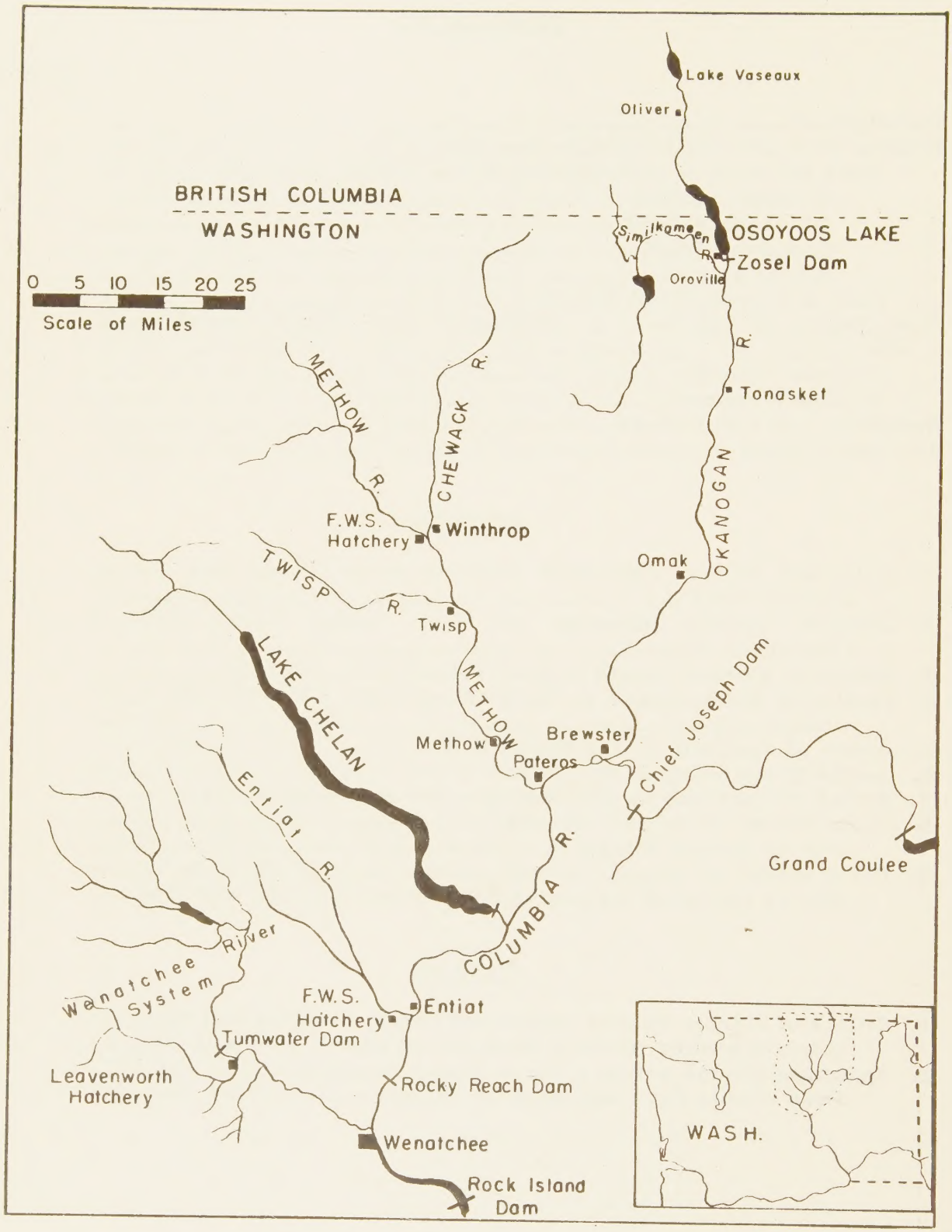

Figure 1.--Columbia River watershed between Rock Island and Grand Coulee Dams.

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ABSTRACT

Important runs of salmon pass Rocky Reach Dam site on the Columbia River. The escapement of chinook salmon past Rocky Reach in 1957 was estimated to be approximately 11,000 spring chinook which spawn in the small remote tributaries and 6,000 summer chinook which spawn in the large tributaries of the Columbia River.

Blueback salmon passing Rocky Reach Dam site in 1956 and 1957 accounted for approximately 72 and 60 percent of the escapement passing Rock Island Dam, or about 67,000 fish in 1956 and 43,000 fish in 1957. They spawn in the Okanogan River in Canada. The rate of travel of blueback salmon was 13.5 miles per day.

INTRODUCTION

Upon the completion of Grand Coulee Dam in 1938, anadromous fish runs were blocked from about 1,140 lineal miles of spawning and rearing areas above the dam (Fish and Hanavan, 1948). At that time anadromous fish were transplanted to the tributaries between Rock Island and Grand Coulee Dams. These tributaries and the Columbia River between Chief Joseph and Rock Island Dams, totaling about 340 lineal miles of stream, now provide the spawning and rearing areas for anadromous runs passing Rock Island Dam (fig. 1).

Chelan County Public Utility District No. 1 is engaged in the construction of Rocky Reach Dam located approximately 21 miles above Rock Island Dam. This dam poses problems for passing anadromous fish runs upstream and downstream and for maintaining adequate spawning areas if major spawning areas are eliminated by flood waters of the forebay. The Fish and Wildlife Service agreed to provide basic biological information on the present salmon escapements of chinook salmon *(Oncorhynchus tshawytscha)*, blueback salmon *(Oncorhynchus nerka)*, silver salmon *(Oncorhynchus kisutch)*, and the steelhead trout *(Salmo gairdneri)*. Studies on the steelhead were limited to examination of their abundance and times of arrival at Rock Island Dam. This basic

Note.--R. R. French and R. J. Wahle, Fishery Research Biologists, Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Seattle, Washington.

biological information will also provide a basis for comparisons of the runs in future years. During 1956 and 1957 the Service made studies on (1) the size and time of migration of various species past the dam site, (2) the rate of travel of migrating fish past Rocky Reach Dam site before the dam is built, and (3) tributary spawning areas used by various segments of the run.

To accomplish these objectives we have used the fish-count data at Rock Island Dam for determining the size and time of escapements at Rocky Reach Dam site 21 miles upstream. Tagging experiments provided information on the rate of travel of blueback salmon, and stream surveys in which spawning salmon were counted in the streams were used for obtaining salmon spawning data.

Financial support for this study was provided by Public Utility District No. 1 of Chelan County, Washington.

SALMON RUNS PAST ROCKY REACH DAM SITE

Over the years salmon become specifically adapted to their environment and become established in certain streams and watersheds in varying abundance. The purpose of the investigation was to determine the abundance of these upriver runs and the arrival times of these runs at the new Rocky Reach Dam site.

Since it was not possible to count fish there, the arrival times of the runs at Rocky Reach Dam site was estimated from a study of the arrival times of fish at Rock Island Dam 21 miles downstream. The daily counts of salmon and steelhead were graphed to show the seasonal pattern of migration, and by applying known rates of travel of different species, we were able to estimate their arrival times at Rocky Reach Dam site.

The size of escapements passing Rocky Reach Dam site was estimated by applying to the Rock Island Dam count the ratio of spawners observed in spawning streams above and below Rocky Reach Dam site. Totals of peak salmon counts for the Wenatchee River system and river systems above Rocky Reach were compiled, and a ratio obtained of the number of spawners found in the two areas. This ratio was then applied to the escapement counted at Rock Island Dam to obtain an estimate number of fish passing Rocky Reach Dam site. For example, if 1,000 spawners were counted in all streams and 700 were observed in streams above Rocky Reach, then 70 percent were deemed to have passed Rocky Reach. Thus, if 10,000 chinook had been counted at Rock Island Dam, 7,000 fish would be estimated as having passed Rocky Reach Dam site.

Stream surveys were made periodically by foot or by boat and the number of fish of each species of salmon was recorded. Peak counts, which were the largest number counted in any one survey, became the basis of comparisons. Survey counts do not represent the total number of spawners present in a stream in a season. Such information cannot be obtained from stream surveys. However, as these survey counts were taken in the same manner and by the same personnel, we feel they gave a usable estimate of the comparative abundance of spawners in the different streams.

Time and size of runs passing Rocky Reach Dam site

Blueback salmon were found to migrate upriver at the rate of 13.5 miles per day (see later section); thus, they would be expected to pass Rocky Reach Dam site, 21 miles upstream from Rock Island Dam, by the second day after passing Rock Island Dam. Chinook salmon in the Snake River were reported to migrate at rates of 13 and 15 miles per day.[1] Either of these rates indicates that chinook runs passing Rock Island Dam would pass the

[1] Thompson, Robert N., James B. Haas, Lawrence M. Woodal, and Edwin K. Holmberg. 1958. Results of a tagging program to enumerate the numbers and to determine the seasonal occurrence of anadromous fish in the Snake River and its tributaries. Fish Commission of Oregon, Contract Report DA 35-026-eng-20609, Portland. 202 pp. Processed.

Rocky Reach site 1½ or 2 days later. Therefore, the arrival times of the blueback and chinook runs at Rock Island Dam have been used as the approximate times the runs would be expected at Rocky Reach Dam site.

The rates of travel of individual steelhead were found to vary widely in the Columbia River between Bonneville and McNary Dams. Schoning, Johnson, and Merrell, in an unpublished report, found that these rates varied from 1.9 to 14.6 miles per day.[2] Thus steelhead could be expected to pass Rocky Reach from 2 to 12 days after passing Rock Island Dam.

Chinook salmon.--The season of passage and the number of chinook salmon passing Rock Island Dam are given in figure 2. Chinook runs in the Columbia River are composed of spring, summer, and fall segments according to the time they enter the river. Each season, the chinook salmon escaping the fishery appear during the same time period at Rock Island Dam; spring chinook pass in May and June, summer chinook pass in July and August, and fall chinook make their appearance after August. The spring and summer chinook runs are fairly well defined by their period of passage at Rock Island Dam. The fall run, however, is not clearly marked and appears as a minor part of the escapement late in the season. Fish and Hanavan (1948) reported on the bimodality of the chinook runs at Rock Island Dam and reported that the spring run apparently terminates during early July. They did not report on the existence of a fall run, but evidence of a fall run at Rock Island Dam is presented in a later section of this report. Considerable overlap of the three segments occurs. All three groups should be expected at Rocky Reach Dam site during the same time period as at Rock Island Dam.

Spawning ground counts above and below Rocky Reach Dam site and counts of spring and summer chinook at Rock Island Dam are given in table 1. We found that 77 percent of the spring chinook counted in 1956 and 65 percent in 1957 were in areas above Rocky Reach. In 1957 this meant that about 65 percent of the spring run counted over Rock Island, or approximately 11,000 fish, were estimated as having passed Rocky Reach Dam site. Twenty-one percent in 1956 and 19 percent in 1957 of the summer chinook were counted in areas above Rocky Reach Dam site. Thus, in 1957 the population of summer chinook passing Rocky Reach was estimated at 6,000 fish. Counts of spring and summer chinook runs passing Rock Island Dam in 1956 were not reliable because of the overlap of the runs that season. The reason for this overlap is discussed in a following section.

Fall chinook salmon spawn in the Columbia River in the limited area between Rock Island Dam and Rocky Reach Dam site, and on extensive spawning riffles above Rocky Reach. Determination of their abundance in this stretch of the main Columbia River was assigned to another fishery agency.

Blueback salmon.--Blueback salmon, first appearing at Rock Island Dam in early July, show a peak of abundance around July 15 to 25. (see figure 3.) To determine the size of the blueback escapement passing Rocky Reach Dam site we have used the seasonal counts of blueback at Tumwater Dam (fig. 1) as the number of blueback entering the Wenatchee River system. The remaining part of the run, or Rock Island Dam counts minus the Tumwater Dam counts, has been used as the estimated number passing Rocky Reach Dam site. This procedure was in preference to using stream surveys for obtaining ratios of blueback salmon in the two areas. In recent years the Okanogan run has been the larger of the two runs. Counts of the Wenatchee River run at Tumwater Dam for 1954-57 have ranged from 28 to 40 percent of the total escapement counted at Rock Island Dam. The remaining 60 to 72 percent of the blueback runs for these years has been attributed to the Okanogan run. The estimate of the blueback run passing Rocky Reach Dam site

[2] Schoning, Robert W., Donald R. Johnson, and Theodore R. Merrell. 1950. The expected appearance of certain runs of Columbia River salmon at McNary Dam. Fish Commission of Oregon, February, unpublished report., 15 pp. Portland.

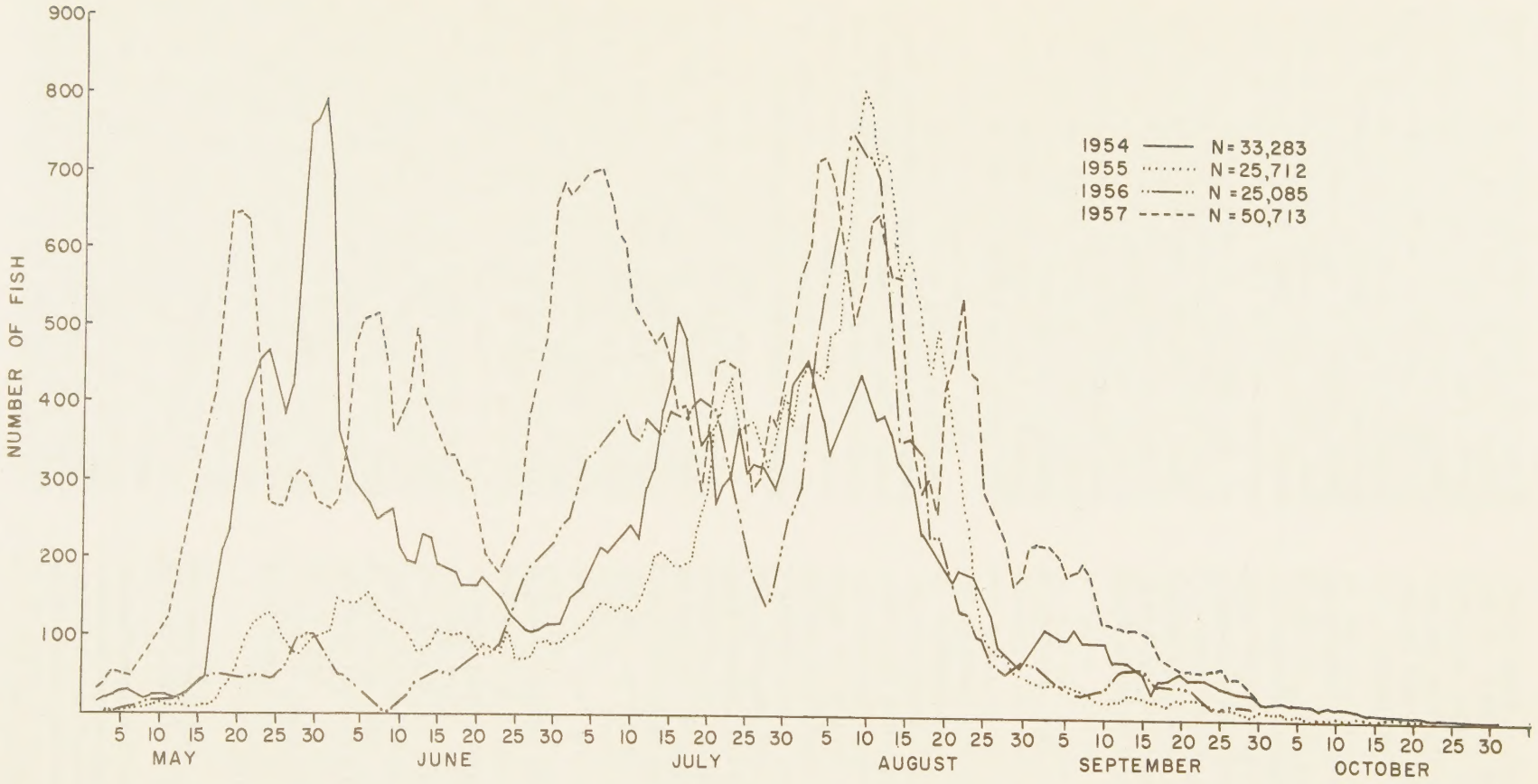

Figure 2.--Chinook salmon passage at Rock Island Dam, 1954-57 (smoothed by 5).

Table 1.--Stream survey and Rock Island Dam counts of spring and summer chinook, 1956-57

Area	Chinook salmon counts[1]			
	1956[2]		1957	
	Spring	Summer	Spring	Summer
Counts above Rocky Reach Dam site....	1,093	575	3,097	1,787
Counts below Rocky Reach Dam site (Wenatchee River system).....	334	2,147	1,672	7,407
Total survey counts.....	1,427	2,722	4,769	9,194
Percentage above Rocky Reach.....	77	21	65	19
Counts at Rock Island Dam.....			16,631	29,914

[1] The week ending June 25 was the division date separating spring and summer chinook; the week ending August 27 was the division date for summer and fall chinook.
[2] In 1956 overlap of runs precluded separation of spring and summer chinook.

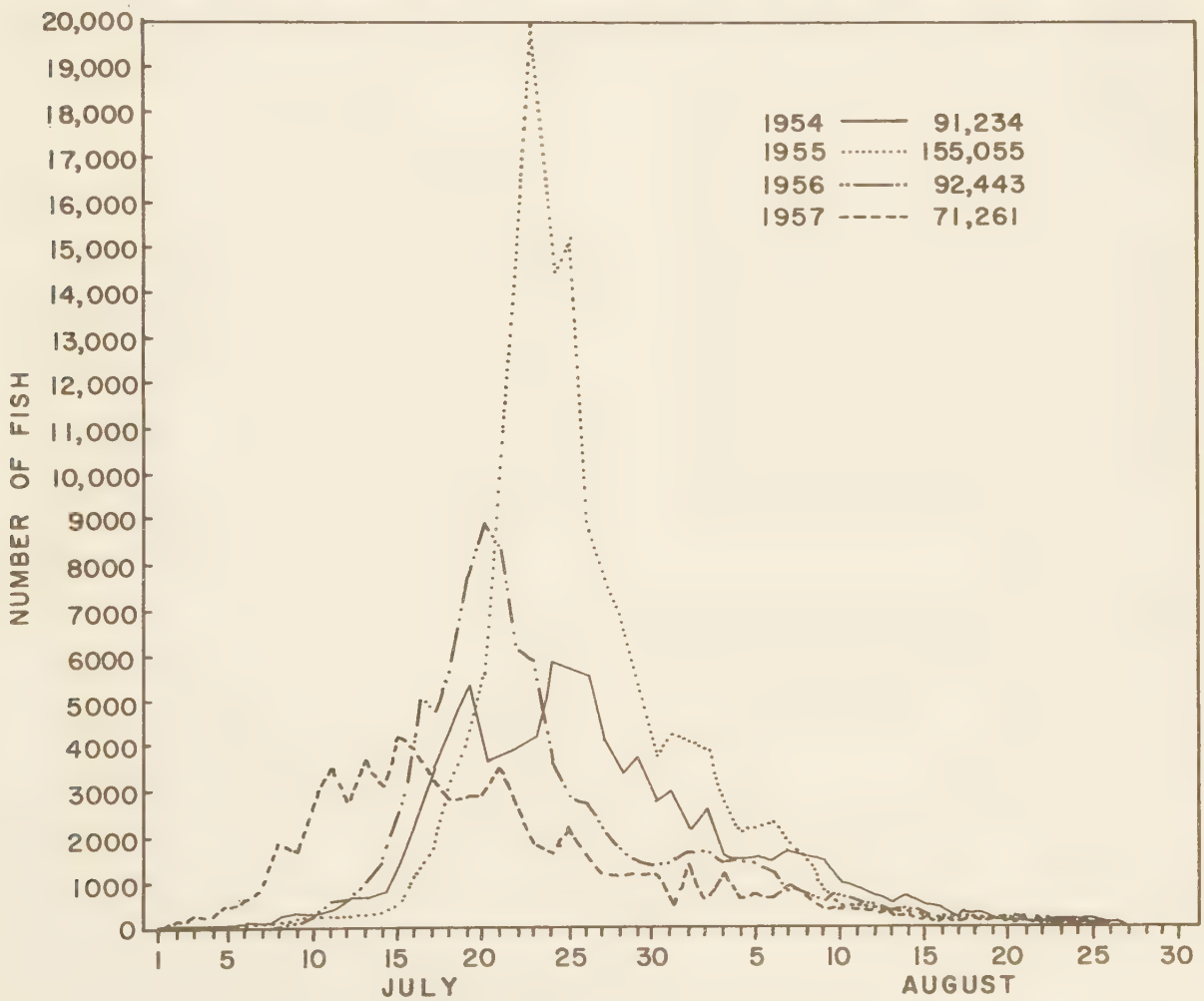

Figure 3.--Blueback salmon counts at Rock Island Dam, 1954-57.

in 1956 was 67,000 fish, or 72 percent of the Rock Island Dam counts. In 1957 the estimate was 43,000 blueback or 60 percent of the Rock Island Dam counts.

Steelhead trout.--Two groups of steelhead runs pass Rock Island Dam, the spring run, which pass in mature condition and are destined to spawn that same season, and the fall run, which pass Rock Island from July through October and forms the larger group of the two, figure 4. As counting at Rock Island Dam is not continuous during winter months but consists of periodic counts at the three ladders, the migration during this period is not fully known. These periodic counts at the various ladders at Rock Island have revealed some movement of steelhead throughout the winter months. Presumably, spawning of steelhead occurs throughout the accessible river systems

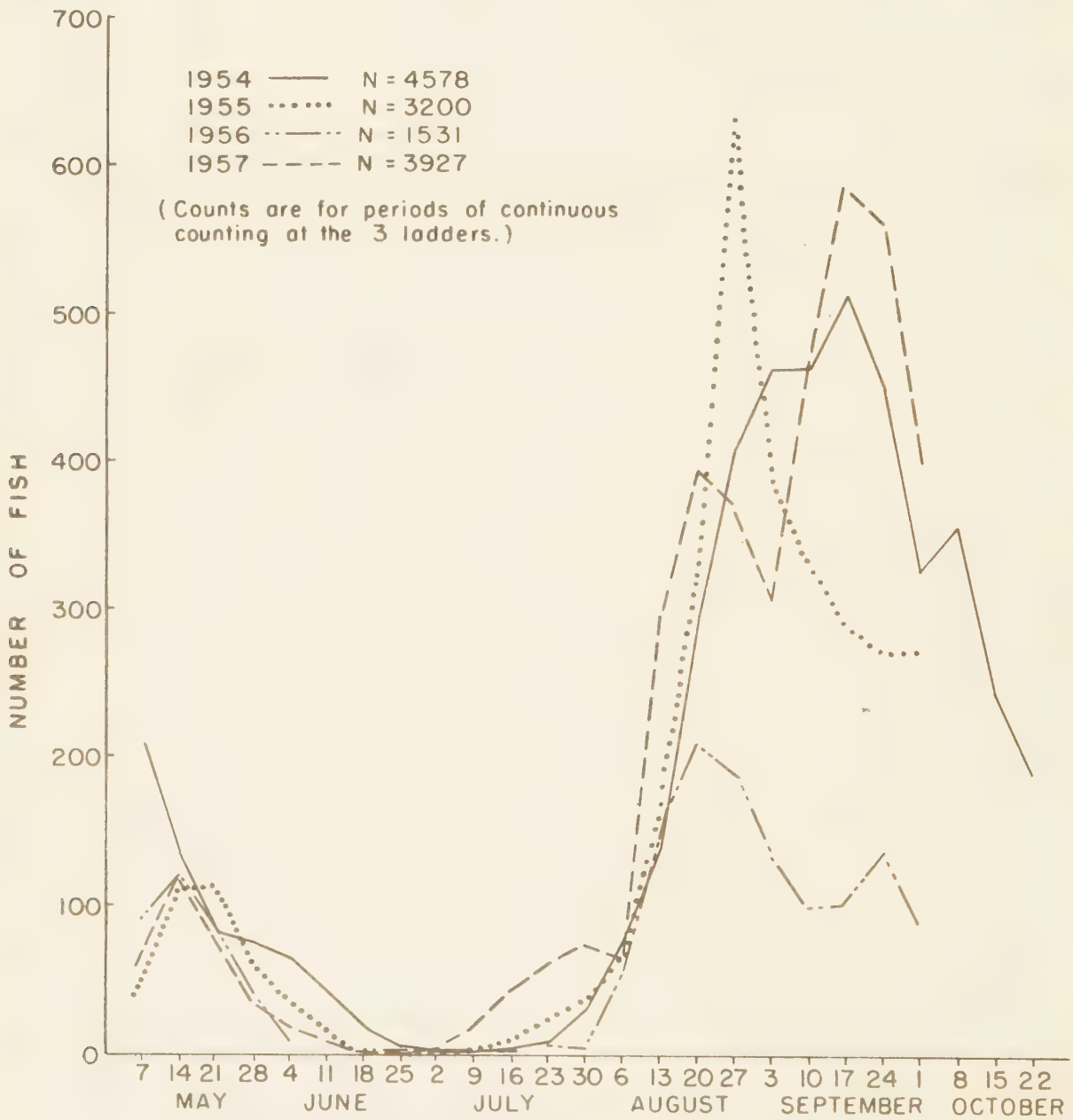

Figure 4.--Steelhead trout counts at Rock Island Dam, 1954-57. (totals by weeks).

above Rock Island Dam, although no spawning ground counts were obtained. Sizes of steelhead runs passing Rocky Reach were not estimated.

Silver salmon.--Silver salmon are few in this area at the present time. Total yearly counts of silver salmon at Rock Island Dam for 1954-58 have ranged from 40 to 94 fish. These fish pass Rock Island Dam during September, October, and November. Formerly silver salmon were abundant. Records show that approximately 6 to 7 million silver salmon eggs were taken annually from the Wenatchee River alone during the years 1899 to 1902. From 1910 to 1920 the numbers of silver salmon eggs taken annually at the Methow River hatcheries ranged from a few thousand to nearly 3 million (Washington State Department of Fisheries, 1899-1920). These silver salmon runs, though of little value now, could possibly be improved.

Rate of travel--Rock Island to Zosel Dam

The rate of travel for blueback salmon between Rock Island Dam and Zosel Dam (figure 1) was determined prior to the building of Rocky Reach Dam in order to ascertain if delays in migration result from the new dam now under construction. The question of delay and its effect upon migrating salmon has long been a matter of conjecture among fishery biologists. The actual effect of a short-term delay or the accumulated effect of several short-term delays to migrating salmon is not known. The most notable example of the effect of a delay in migration has been the blockade at Hell's Gate on the Fraser River. Here, fish that were delayed longer than 14 days did not reach the spawning ground. During these experiments fish captured, tagged, and liberated were often recaptured below the gate and the interval between captures was termed delay (Talbot, 1950). In reference to the Columbia River and many dams now built or contemplated along salmon migration routes, one of the problems is whether dams cause delays over and above the effects of pre-existing conditions; and if delays are caused, what might be the cumulative effect of many dams.

Knowing Rocky Reach Dam was to be constructed we decided to determine the rate of travel of salmon through this stretch of river before construction. Then in the future it may be possible to determine if Rocky Reach Dam delays passage of migrating fish.

In 1957, to determine the rate of travel through this stretch of river, blueback salmon were tagged with various colored tags, were released in the forebay at Rock Island Dam, and were observed at Zosel Dam approximately 145 miles upstream on the Okanogan River. The use of combinations of colored tags enabled us to identify tagging dates as tagged fish passed an observation point. Zosel Dam, the observation point, is a small wooden structure designed to form a pool for logging operations at a nearby mill. Observers recorded the daily passage of tagged and untagged fish through the fishways at this dam; however, fish were also able to pass the dam through cracks in the wooden weirs. As few recoveries were made from the 1957 experiments, the data from tagging experiments of 1954 and 1955 were used to obtain rates of travel between Rock Island and Zosel Dams. These experiments in 1954 and 1955 were similar to the 1957 experiments and were for the purpose of studying the efficiency of the Rock Island Dam fishways.

In addition to tagging experiments, peak counts at Rock Island and Zosel Dams were used to determine the rate of travel by computing the difference in time between the peaks in abundance at the two places.

The data obtained from the blueback tagging experiments at Rock Island Dam in 1954-55 are presented below. "Days out" represents the time interval between tagging at Rock Island and recovery at Zosel Dam. The day of tagging is treated as zero day. The data from the two seasons were combined because the means and variances

of the days-out period of the two recovery groups were not statistically different.

Number of tag recoveries	30
Average number of days out	10.7
Range of days out	7 to 16

Since the distance between Rock Island Dam and Zosel Dam is about 145 miles, the average rate of travel is 13.5 miles per day.

The results of a comparison of the time of peak counts of blueback salmon at Rock Island and Zosel Dams were found to agree with results of the tagging studies. In 1953 the mode at Rock Island Dam occurred during the period July 15-22, with a maximum count on July 18. At Zosel Dam the mode occurred during the period July 23-30, with the maximum noted on July 28. Thus, the difference in time between maximum counts (10 days) compares closely with the 10.7 days travel time established by tagging studies. Other seasons could not be compared as no definite peaks in abundance were noted at Zosel Dam.

DISTRIBUTION OF SPAWNERS IN TRIBUTARIES ABOVE ROCKY REACH DAM SITE

Salmon are known to be attracted to certain spawning areas in a river system, if the flow, temperature, gravel, and other requirements are fulfilled. Normally, there is very little straying from these spawning areas from year to year. The purpose of the investigation was to discover the spawning areas now used by salmon in the tributaries above Rocky Reach Dam site.

Stream surveys were made to determine the distribution and comparative abundance of spawners in the tributary streams. While the survey counts do not represent the total numbers of spawners present, the counts are of value in determining the distribution and comparative abundance of spawners from year to year and in different streams, providing the surveys are made in the same manner. Aerial surveys, of the number of salmon nests were used as an aid in locating the area of spawning in the Okanogan River from Oroville to Brewster.

Tagging experiments at Rock Island Dam gave additional information about spawning areas of the different segments of the runs which pass Rocky Reach Dam site. Although these experiments were designed for evaluating the fishways, they also yield data which are applicable to this study. Chinook and blueback salmon were tagged throughout most of their period of migration at Rock Island Dam during the 1954, 1955, and 1956 experiments. Many tagged salmon were recovered on the spawning grounds, and from their distribution we learned which spawning areas were used by various segments of the run.

Chinook salmon

Peak counts of salmon and the time period encompassing the peak of spawning are listed in table 2. These counts serve to exemplify the relative importance of each tributary stream. Note the increased counts in each stream in 1957 over those of 1956. Total counts of chinook salmon are about 3 times the counts obtained in 1956.

The distribution of fish within the streams is illustrated in figures 5, 6, and 7. The stream lengths have been drawn to scale; the widths, however, have been exaggerated in order to show areas of spawning. The symbols represent the comparative abundance of individual species within each stream. As observed, spring chinooks spawn in the smaller tributaries and more remote areas of the tributaries, and summer chinooks in the larger main tributaries.

The distribution of spawning chinook salmon according to the time of season they passed Rock Island Dam is graphically illustrated by the recovery of tagged fish on the spawning grounds. The history of chinook salmon escape-

Table 2.--Spawning ground surveys above Rocky Reach Dam site 1956-57. Peak counts (live and dead) of chinook and blueback salmon

Species and name of stream	Salmon counts		Period of peak of spawning
	1956	1957	
CHINOOK SALMON			
Entiat River	149	273	Aug. 20-30
Twisp River	191	702	Aug. 10-20
Chewack River	404	1,065	Aug. 15-25
Methow River			
Above Winthrop	249	909	Aug. 20-30
Winthrop to Twisp	141	148	Sept. 5-15
Twisp to Pateros	375	1,398	Oct. 5-15
Similkameen River	101	189	Oct. 10-20
Okanogan River			
Oroville to Brewster[1]	99	[2] 8	Oct. 15-25
BLUEBACK SALMON			
Okanogan River			
Above Lake Osoyoos	16,067	8,533	Oct. 1-10

[1] During aerial surveys of this section following the peak of spawning, 37 salmon redds were counted in 1956 and 53 redds in 1957.
[2] Survey too early for spawning peak.

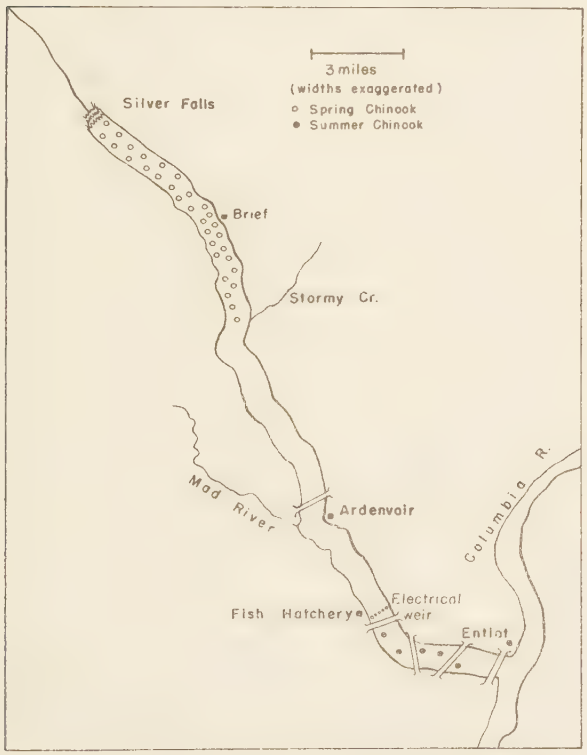

Figure 5.--Areas of spawning in the Entiat River.

ment at Rock Island Dam shows the separation of spring and summer chinook runs to occur sometime between June 25 and July 9. Accordingly, tag recoveries were plotted by these periods in which spring and summer chinook are known to have passed the dam, figure 8. The period between June 25 and July 9 was chosen as a period of overlap of the two runs. It is observed that for the combined tagging data of 1954 and 1955 no tagged spring chinook were recovered on the summer chinook spawning areas; only one tagged summer chinook was noted in spring chinook spawning areas. Fish tagged during the period of overlap were found in both areas.

The 1956 tagging experiments at Rock Island Dam indicate that spring chinook may not always pass Rock Island Dam and Rocky Reach Dam site in the periods indicated. The distribution of tagged fish by season of passage at Rock Island for 1956 is shown in figure 9. Many fish tagged after July 9, 1956

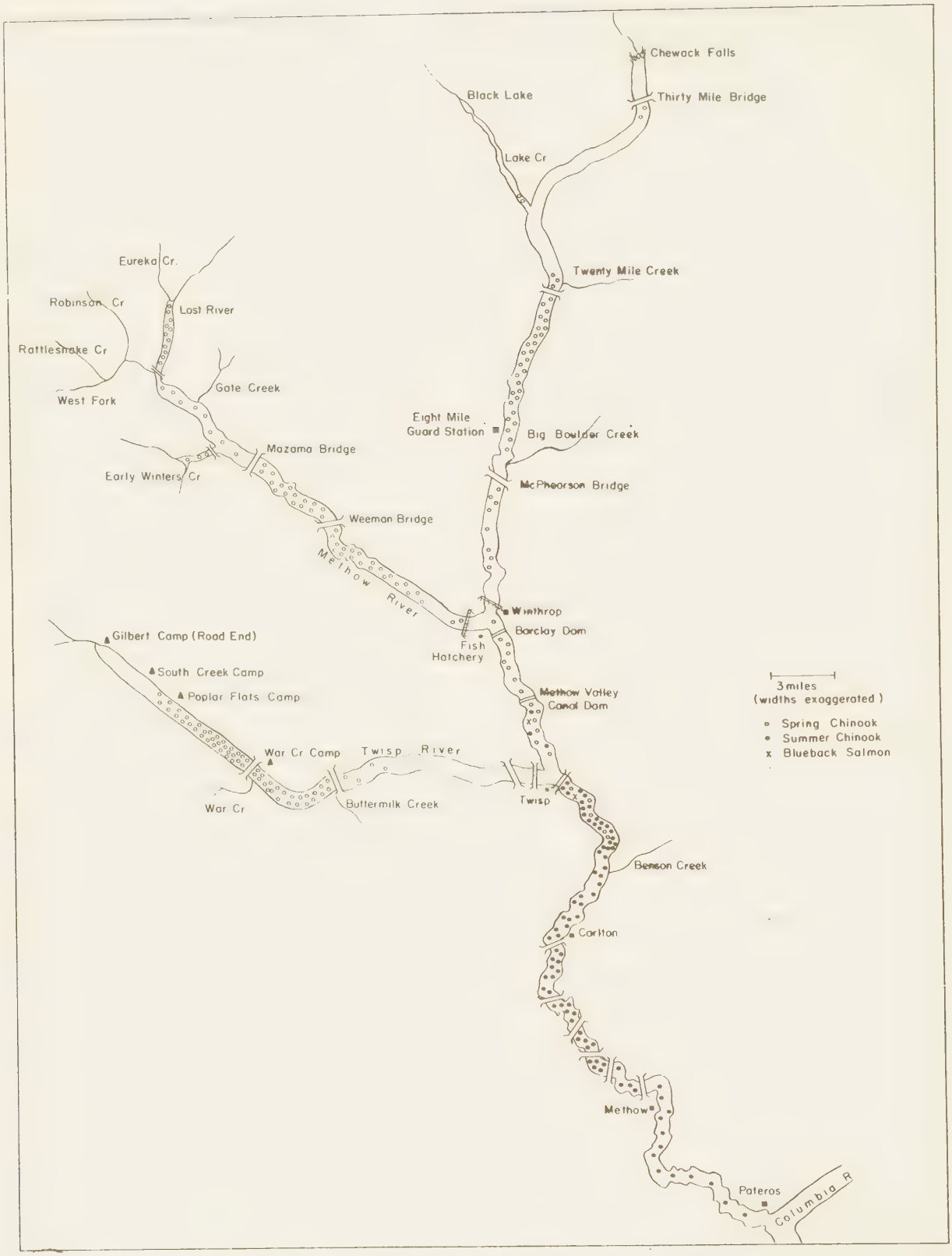

Figure 6.--Areas of spawning in the Methow River system.

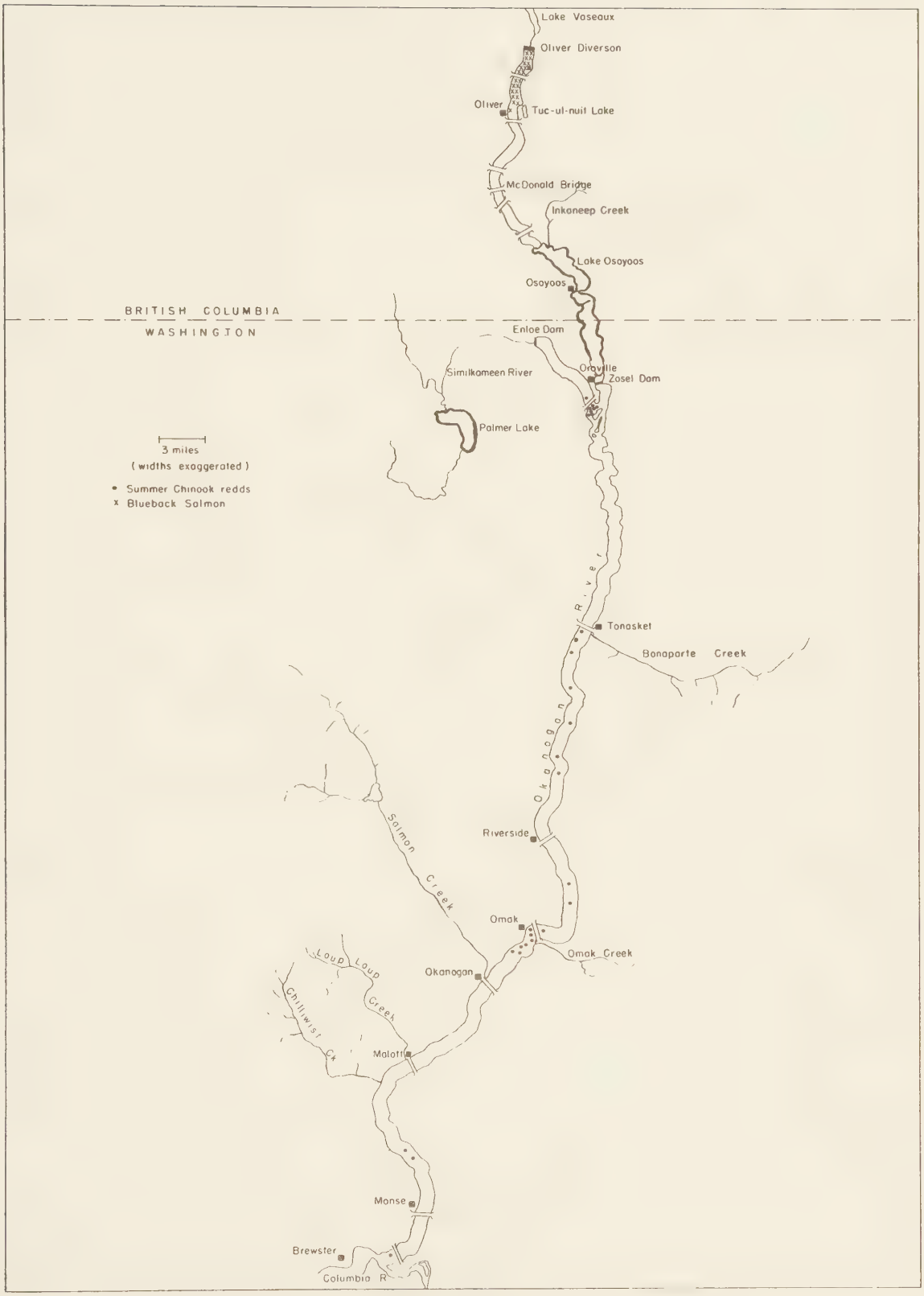

Figure 7.--Areas of spawning in the Okanogan and Similkameen Rivers.

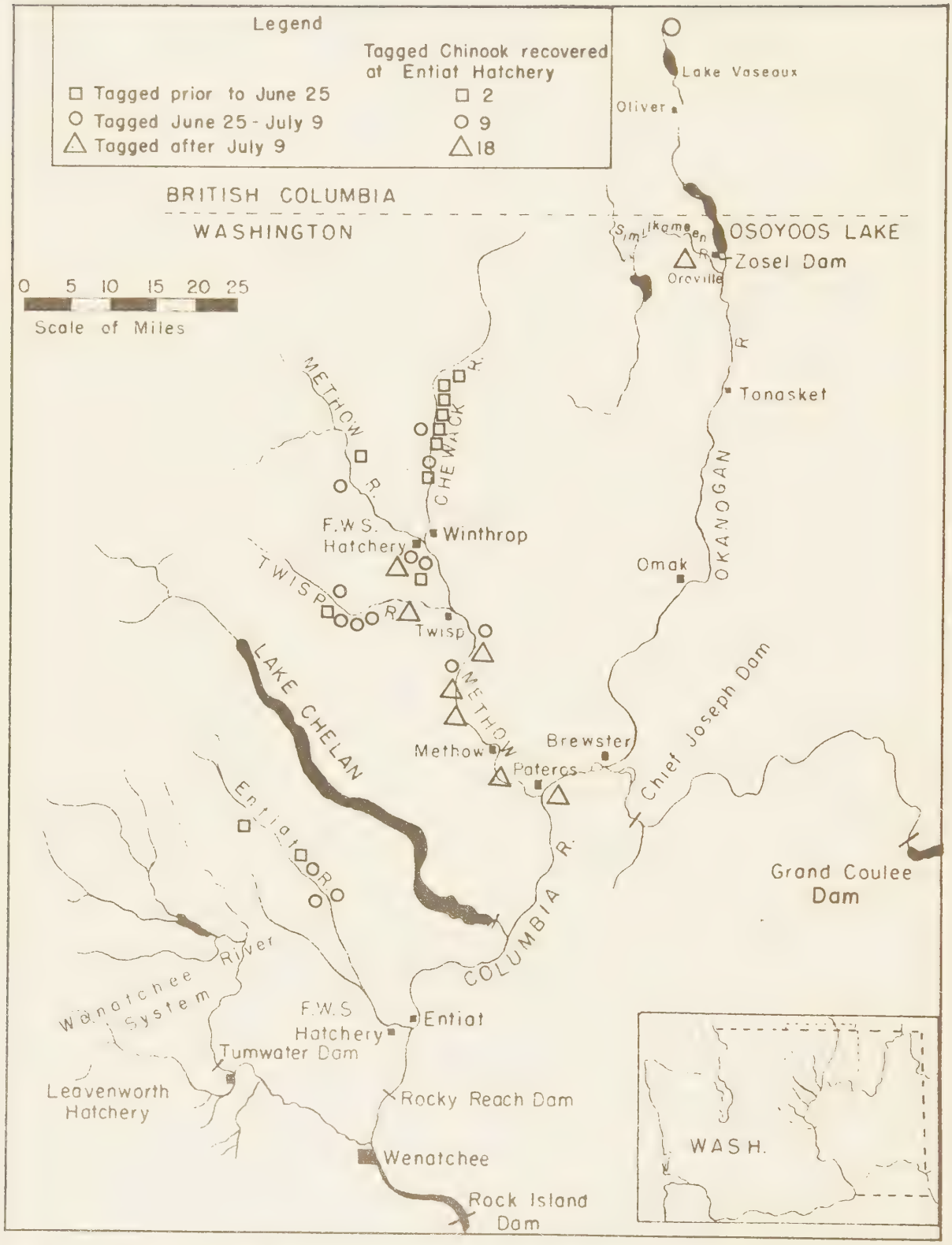

Figure 8.--Distribution of tagged chinook salmon above Rocky Reach Dam site by period of tagging at Rock Island Dam, 1954 and 1955.

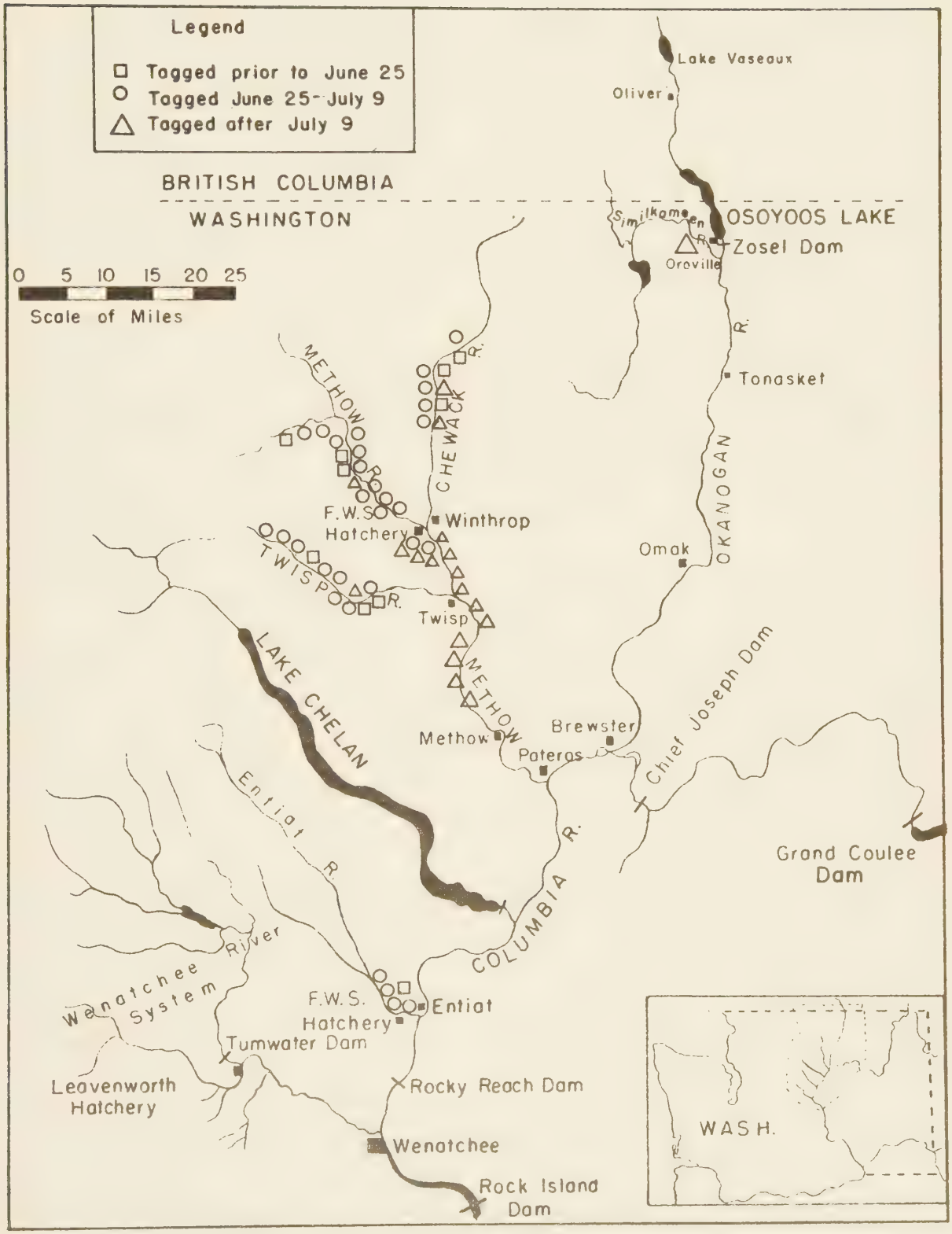

Figure 9.--Distribution of tagged chinook salmon above Rocky Reach Dam site by period of tagging at Rock Island Dam during 1956.

appeared in spring chinook spawning areas. These were spring chinook and not summer chinook as evidenced by their characteristic small size, greenish-gray appearance, and early spawning. Summer chinook average larger, take on a reddish color in spawning streams, and spawn later in the season. Apparently a delay along the migration route was responsible for the unusually late passage of many spring chinook at Rock Island Dam. Davidson[3] noted that the upstream salmon migration in the Columbia River is retarded by floods, and at stages of extreme high water may be inhibited. In 1956 a minor flood occurred in the Columbia River and the unusually late passage of many spring chinook could be attributed to this occurrence. It should be noted that none of the fish tagged prior to July 9 was recovered in summer chinook spawning areas that season.

Another tagging experiment conducted during 1956 confirmed our belief that fall chinook spawn in the main Columbia River. Sixty-two chinook from the September migration at Rock Island Dam were tagged and released over a 3-day period. No tagged fish were recovered from this lot during the stream surveys made on all tributary streams. For similar experiments in August, however, in which the number tagged ranged from 24 to 70 chinook, some tags were recovered. Total recoveries from these summer experiments averaged 10 percent. If the fall escapement of chinook salmon spawned in the tributaries, surely some tags would have been recovered; six fish would have been recovered if the 10 percent average were obtained. It seems certain that these fish spawn only in the main Columbia River, but because of the difficulty of finding tagged fish in so large a river, no recovery was attempted there.

Blueback salmon

Majority of the blueback salmon passing Rocky Reach Dam site are bound for the spawning areas in the Okanogan River in Canada as evidenced by the stream surveys (see fig. 7). Very few blueback salmon enter the Entiat, Methow, and Similkameen Rivers. Blueback salmon tagged during all parts of the migration period at Rock Island Dam were recovered on the Okanogan River spawning grounds. Spawning commences in the Okanogan River during the last week in September and continues throughout the month of October.

[3] Davidson, F. A. 1957. The effect of floods on the upstream migration of the salmon in the Columbia River. Public Utility District No. 2 of Grant County (Ephrata, Washington). 20 pp. Processed.

SUMMARY AND CONCLUSIONS

Investigations of fish runs passing Rocky Reach Dam site have revealed that important runs of chinook and blueback salmon pass the site bound for spawning areas in all main tributaries between Rocky Reach and Chief Joseph Dam. The runs passing Rock Island Dam would be expected at Rocky Reach Dam site within $1\frac{1}{2}$ or 2 days since the dams are only 21 miles apart.

For 1957 the spring and summer chinook escapement pass Rocky Reach Dam site was approximately 11,000 and 6,000 fish respectively. The escapement of blueback salmon passing Rocky Reach Dam site was approximately 67,000 fish in 1956 and 43,000 fish in 1957.

Steelhead trout and silver salmon are assumed to pass Rocky Reach; however, their numbers were not determined. Although numerous in the area up to the year 1920, very few silver salmon have been counted at Rock Island Dam since counting commenced in 1933.

The rate of travel of blueback salmon between Rock Island Dam and Zosel Dam established from tagging experiments was found to be 10.7 days for the 145 miles distance or 13.5 miles per day. The difference in time between peaks of abundance at Rock Island and Zosel Dam also indicated that about 10 days were required for fish to travel between the two points.

In general, spring chinook spawn in the smaller, more remote tributaries, and summer chinook spawn in the lower main tributaries. Fall chinook spawn in the main Columbia River. Blueback salmon spawn in that part of the Okanogan located in Canada, from Lake Vaseaux to Lake Osoyoos. Scatterings of blueback were also found in the Entiat, Methow, and Similkameen Rivers.

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